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(54) **AIR-SUPPORTED MEMBRANE STRUCTURE DOME AND FOUNDATION THEREOF**

(71) Applicant: **BROADWELL (SHENZHEN) TECHNOLOGY CO., LTD**, Shenzhen, Guangdong (CN)

(72) Inventors: **Long Xiao**, Guangdong (CN); **Hongyi Ding**, Guangdong (CN); **Xiudong Wei**, Guangdong (CN); **Maozhang Huang**, Guangdong (CN)

(73) Assignee: **BROADWELL (SHENZHEN) TECHNOLOGY CO., LTD**, Shenzhen, Guangdong (CN)

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(56) **References Cited**

U.S. PATENT DOCUMENTS

3,462,521	A *	8/1969	Bini	E04B 1/169 249/63
3,643,910	A *	2/1972	Heifetz	E04B 1/169 249/13

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1526044	9/2004
CN	203222807	10/2013

(Continued)

OTHER PUBLICATIONS

International Search Report for international application No. PCT/CN2015/098839, dated Apr. 1, 2016 (6 pages, including English translation).

Primary Examiner — Gisele D Ford
(74) *Attorney, Agent, or Firm* — Hamre, Schumann, Mueller & Larson, P.C.

(57) **ABSTRACT**

An air dome foundation comprises multiple foundation modules (**110**). The multiple foundation modules (**110**) are used to be placed on the ground end to end. The foundation modules (**110**) comprise straight structure and L-shaped structure. The foundation is low in construction cost, short in construction period and suitable for always moving or the
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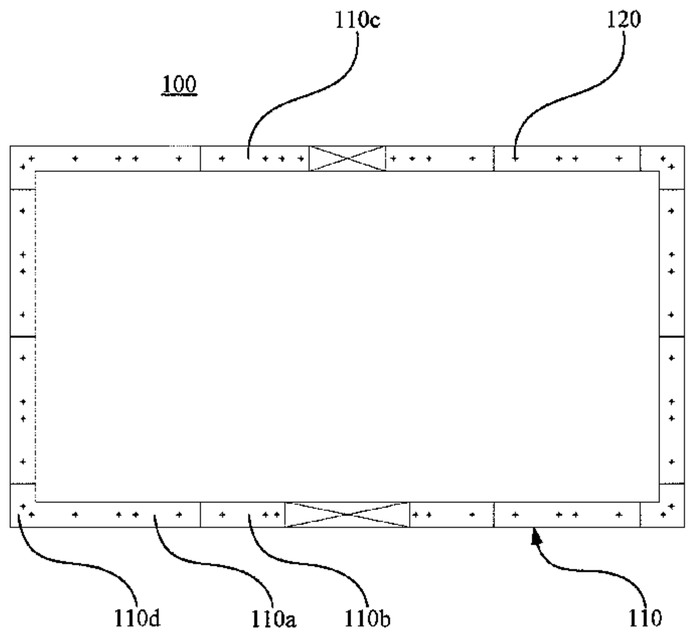

situation in which original ground surface can not be modified or damaged.

6 Claims, 6 Drawing Sheets

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E04H 3/14	(2006.01)
E04B 1/00	(2006.01)
E04H 3/10	(2006.01)
E04H 15/20	(2006.01)
E04H 15/22	(2006.01)

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(58) **Field of Classification Search**
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(56) **References Cited**

U.S. PATENT DOCUMENTS

3,719,341	A *	3/1973	Harrington	E04B 1/169 249/65
4,041,671	A *	8/1977	Nicholson	E04B 1/166 52/2.15
4,064,663	A *	12/1977	Moss	E04B 1/166 52/309.9
4,192,105	A *	3/1980	Morgan	E04H 15/20 52/2.25
4,629,592	A *	12/1986	Harrington	E04G 11/04 249/19
5,177,919	A *	1/1993	Dykmans	B65D 88/34 405/229
5,195,293	A *	3/1993	diGirolamo	E04B 1/24 52/745.13
5,586,841	A *	12/1996	Anderson	B29C 49/2408 405/286
5,918,438	A *	7/1999	South	E04B 1/169 264/32
8,302,357	B1 *	11/2012	Nolte	E02D 31/002 52/220.2
9,695,585	B1 *	7/2017	Seiford, Sr.	E04B 1/3211
2004/0045227	A1 *	3/2004	South	E04B 1/169 52/80.1
2008/0072501	A1 *	3/2008	Ligas	E04H 9/06 52/2.25
2009/0320380	A1 *	12/2009	Chelf	A01G 9/1407 52/2.11
2011/0252722	A1 *	10/2011	Laurin	E02D 27/32 52/126.6

FOREIGN PATENT DOCUMENTS

CN	103510620	1/2014
CN	204385756	6/2015
KR	20100085425	7/2010
KR	20120006062	8/2012

* cited by examiner

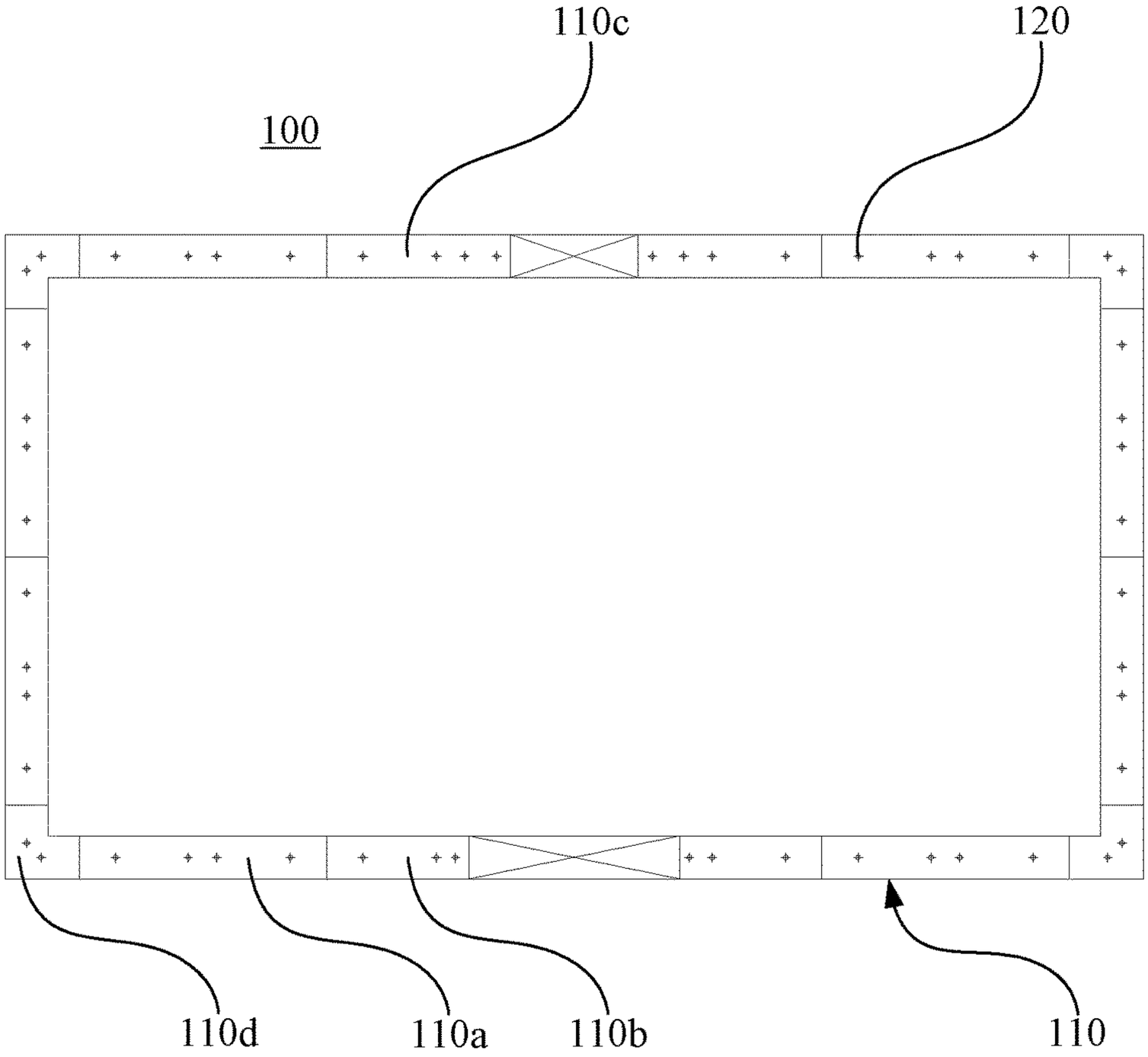

FIG. 1

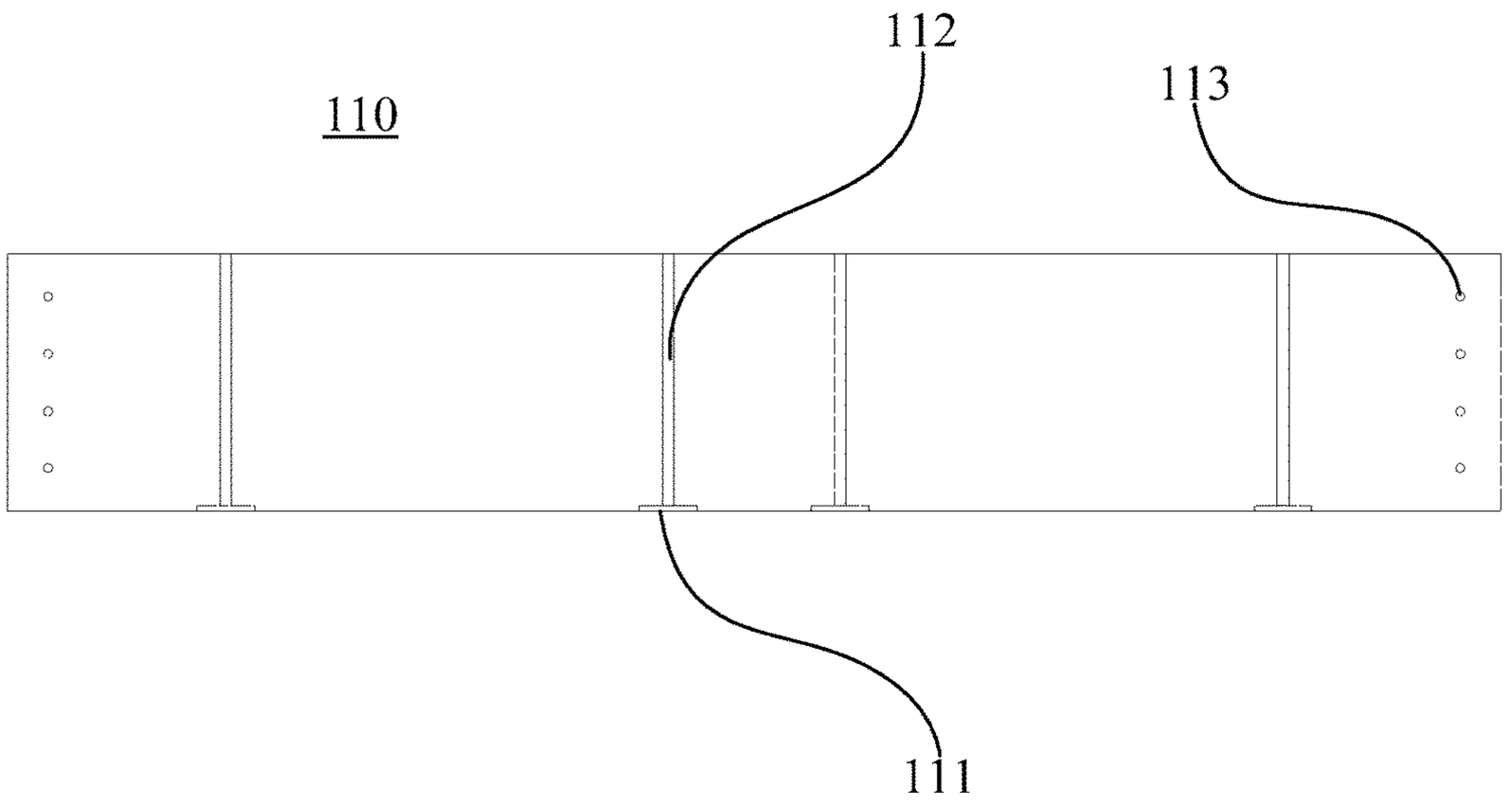

FIG. 2

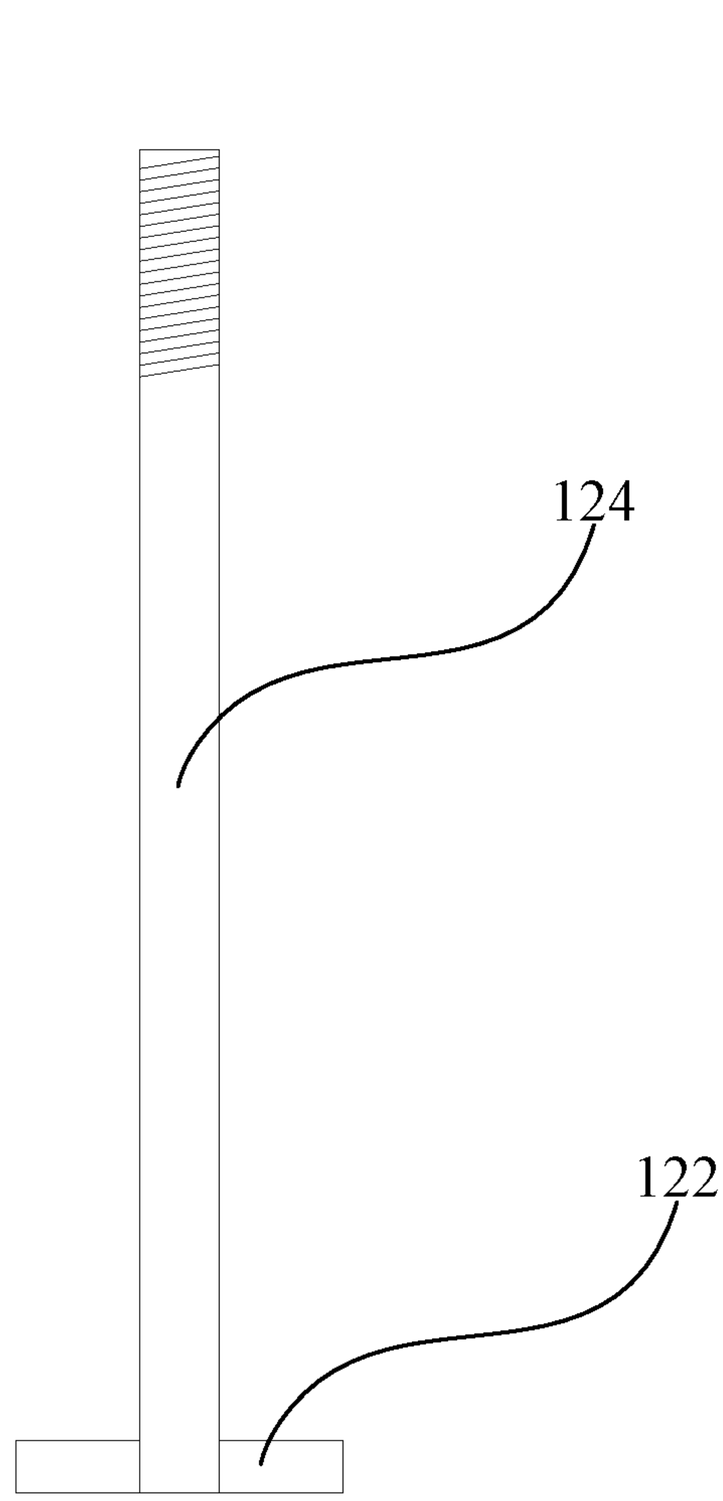

FIG. 3

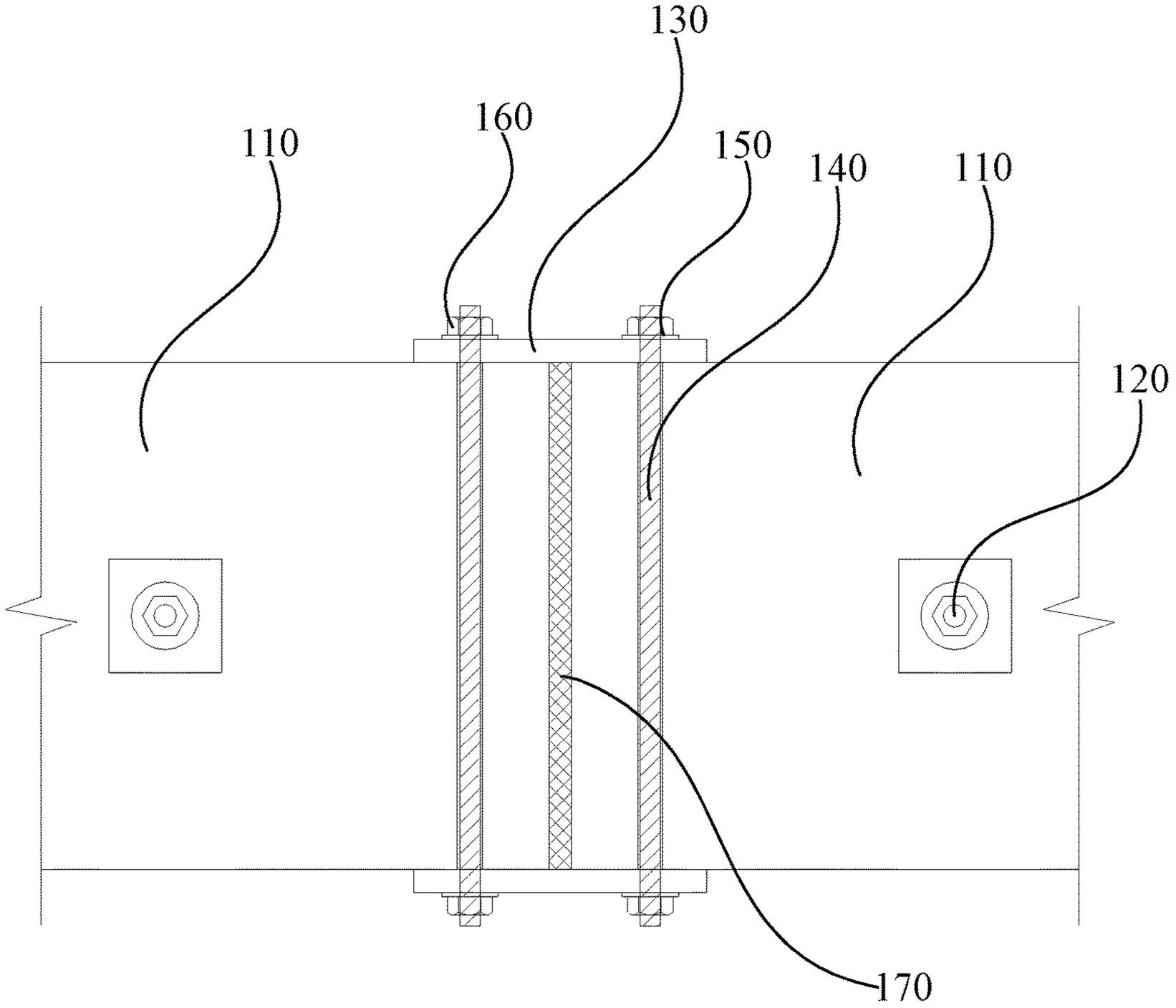

FIG. 4

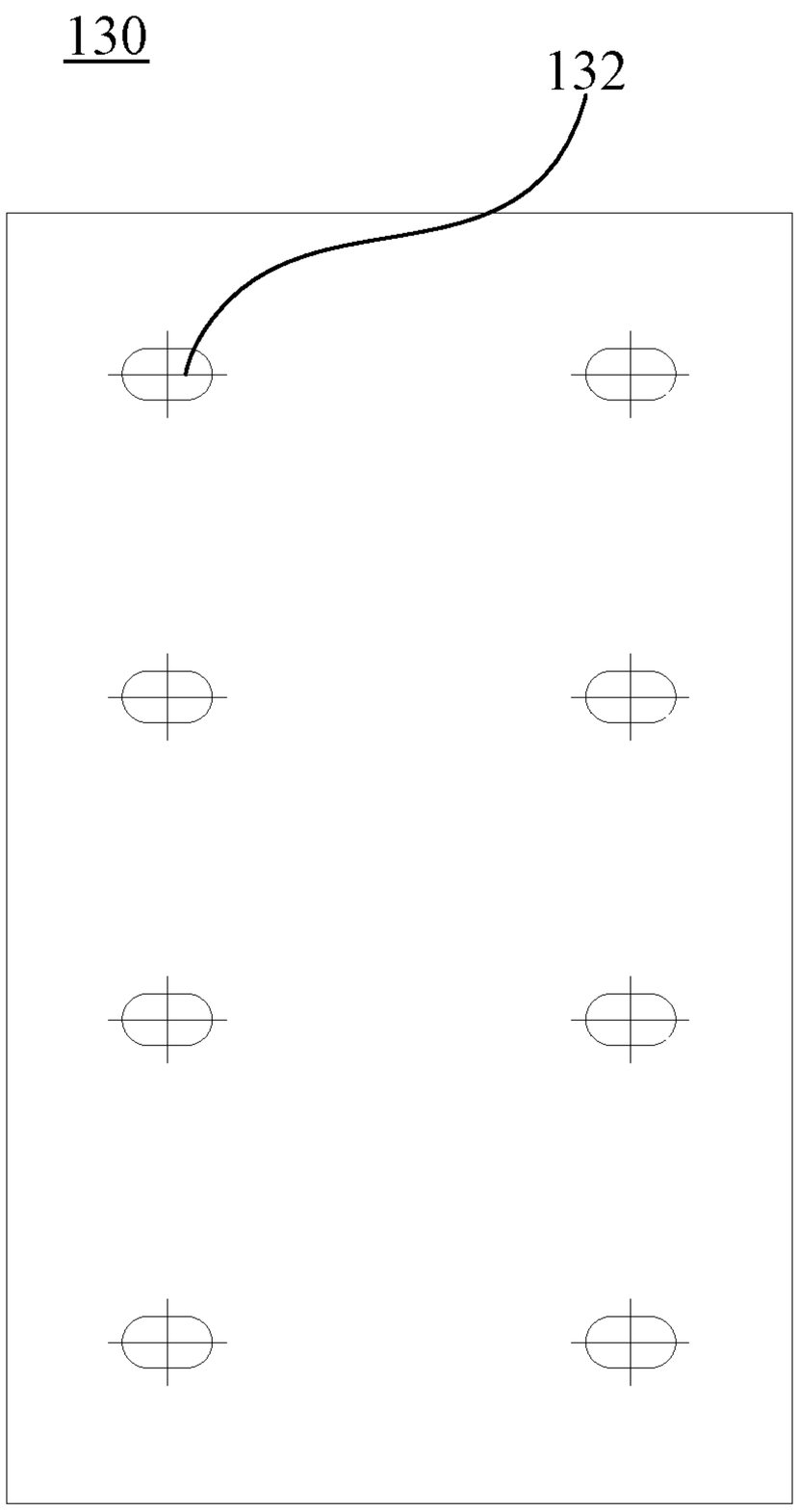

FIG. 5

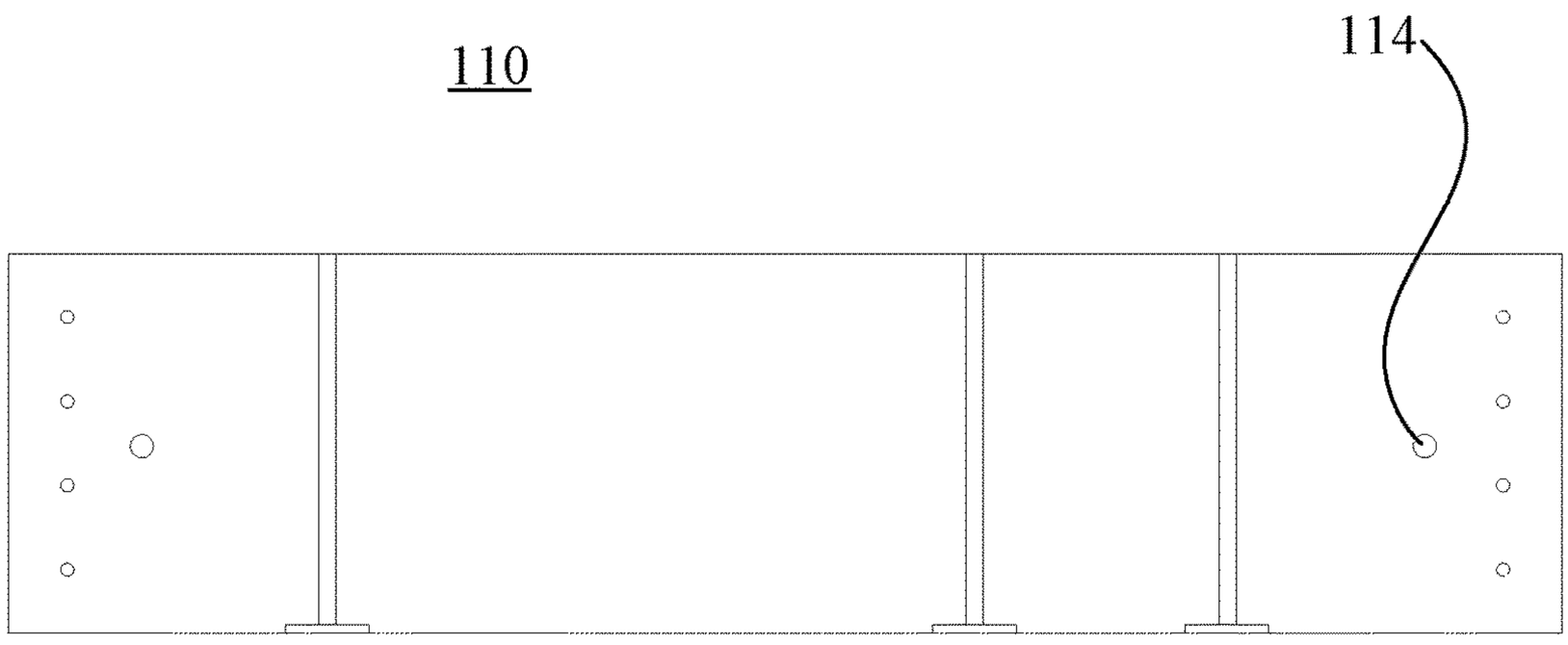

FIG. 6

AIR-SUPPORTED MEMBRANE STRUCTURE DOME AND FOUNDATION THEREOF

FIELD OF THE INVENTION

The present disclosure relates to the field of architecture, and more particularly relates to an air-supported membrane structure dome (air dome) and a foundation thereof.

BACKGROUND OF THE INVENTION

Air dome is a building formed from one or more special architectural membranes anchored to the ground with intelligent air blowers continuously pump air into the structure and support the main structure. Air dome structures offer great flexibility, and can be used as seasonal, permanent or temporary structures, such as industrial plants, warehouses and sports venues.

Foundation is part of the building, its main function is to transfer the vertical load of the building to the ground. The conventional building foundation is subject to downward pressure, while the foundation of the air dome is subject to the upward and lateral tension of the membrane, such that air dome foundation requires a strong anti-pulling capacity, and a stable and low center of gravity.

The conventional foundation of the air dome is generally formed by pouring concrete, which needs to be deeply dug. In order to resist the pulling tension, the foundation of the air dome has a larger bottom and has to be buried underground. With respect to air dome, which is a of new low-cost, short construction cycle, and environmentally friendly construction, the cost and the construction time of the foundation accounts for a large proportion, and when the air dome is moved, the original foundation is abandoned, which will cause a lot of waste for those air dome with frequent movement.

SUMMARY OF THE INVENTION

Accordingly, it is necessary to provide an air dome and its foundation with lower construction cost.

An air dome foundation includes a plurality of foundation modules, a plurality of splicing plates, a penetrating bolt, and an anchor bolt, the anchor bolt includes a bolt head and a main body having a rod-like structure provided on the bolt head;

wherein the plurality of foundation modules are placed on the ground, the foundation module comprises an elongated structure and an L-shaped structure;

both ends of a side of the foundation module are provided with one row of first through holes, the splicing plate is provided with two rows of second through holes, the two rows of second through holes are corresponding to a row of the first through holes on an end of the two adjacent foundation modules, the penetrating bolt extends through the first through hole and the second through hole, such that two adjacent foundation modules are fixed via the splicing plate;

a bottom the foundation module is provided with a counterbore and an anchor bolt hole extending through the foundation module, the counterbore is located at an end of the anchor bolt hole and is in connection with the anchor bolt hole, the bolt head is located in the counterbore, the main body extends through the anchor bolt hole, and an end of the anchor bolt is higher than a top surface of the foundation module.

In one embodiment, the counterbore is a square dimpling, the bolt head is a square bolt head, and the end of the anchor bolt is at least 4 cm higher than the top surface of the foundation module.

In one embodiment, the air dome foundation further comprises a sealing cushion disposed between adjacent two foundation modules or on the bottom surface of the foundation module; or the air dome foundation further comprises a sealing adhesive coated between adjacent two foundation modules or on the bottom surface of the foundation module.

In one embodiment, the foundation module is a concrete foundation module.

In one embodiment, a sidewall of the foundation module is provided with at least one lifting hole and an exhaust hole.

An air dome foundation includes a plurality of foundation modules placed on a ground, wherein the plurality of foundation modules are connected end to end, the foundation module comprises an elongated structure and an L-shaped structure.

In one embodiment, the air dome foundation further comprises a plurality of splicing plates and a penetrating bolt;

both ends of a side of the foundation module are provided with one row of first through holes, the splicing plate is provided with two rows of second through holes, the two rows of second through holes are corresponding to a row of the first through holes on an end of the two adjacent foundation modules, the penetrating bolt extends through the first through hole and the second through hole, such that two adjacent foundation modules are fixed via the splicing plate.

In one embodiment, the air dome foundation further comprises an anchor bolt, the anchor bolt comprises a bolt head and a main body having a rod-like structure provided on the bolt head;

a bottom the foundation module is provided with a counterbore and an anchor bolt hole extending through the foundation module, the counterbore is located at an end of the anchor bolt hole and is in connection with the anchor bolt hole;

the bolt head is located in the counterbore, the main body extends through the anchor bolt hole, and an end of the anchor bolt is higher than a top surface of the foundation module.

In one embodiment, the counterbore is a square dimpling, the bolt head is a square bolt head.

In one embodiment, the end of the anchor bolt is at least 4 cm higher than the top surface of the foundation module.

In one embodiment, the air dome foundation further comprises a sealing cushion disposed between adjacent two foundation modules or on the bottom surface of the foundation module; or the air dome foundation further comprises a sealing adhesive coated between adjacent two foundation modules or on the bottom surface of the foundation module.

In one embodiment, the foundation module is a concrete foundation module.

In one embodiment, a sidewall of the foundation module is provided with at least one lifting hole.

In one embodiment, a sidewall of the foundation module is provided with at least one exhaust hole.

An air dome having the foregoing air dome foundation is provided.

According to the foregoing air dome foundation, the foundation module can be pre-machined in a factory, and transported to the site and installed as needed, thus achieving modularization. During installation, the foundation module can be placed on the ground without excessive treatment to

the ground, such that the construction period is further shortened, and the construction costs are significantly reduced. The air dome foundation is suitable for occasions where frequent movements are needed or existing ground or facilities cannot be modified or destroyed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top view of an air dome foundation according to an embodiment of the present disclosure;

FIG. **2** is a cross-sectional view of a foundation module of the air dome foundation of FIG. **1**;

FIG. **3** is a schematic view of an anchor bolt of the air dome foundation of FIG. **1**;

FIG. **4** is a partial schematic view of the air dome foundation of FIG. **1**;

FIG. **5** is a schematic view of a splicing plate of the air dome foundation of FIG. **1**; and

FIG. **6** is a cross-sectional view of a foundation module according to another embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Embodiments of the invention are described more fully hereinafter with reference to the accompanying drawings. The various embodiments of the invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Elements that are identified using the same or similar reference characters refer to the same or similar elements.

It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, if an element is referred to as being "directly connected" or "directly coupled" to another element, there are no intervening elements present.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

Referring to FIG. **1**, an air dome (not shown) according to an embodiment of the present disclosure includes an air dome foundation **100**. The air dome foundation **100** includes a plurality of foundation modules **110** and a plurality of anchor bolts **120**.

The foundation module **100** is placed on the ground. The plurality of foundation modules **110** are connected end to end, thus forming the illustrated annular structure.

Referring also to FIG. **2**, a bottom the foundation module **110** is provided with a counterbore **111** and an anchor bolt hole **112** extending through the foundation module **110**. The counterbore **111** is located at an end of the anchor bolt hole **112** and is in connection with the anchor bolt hole **112**. Specifically, the counterbore **111** and the anchor bolt hole **112** are provided on a central axis of the bottom of the foundation module **110**.

Referring also to FIG. **3**, the anchor bolt **120** includes a bolt head **122** and a main body **124** having a rod-like structure provided on the bolt head **122**. The bolt head **122** is located in the counterbore **111**, the main body **124** extends through the anchor bolt hole **112**, and an end of the anchor bolt **120** is higher than a top surface of the foundation module **110**.

The anchor bolt **120** is a fastener configured to connect the air dome foundation **100** and membrane (not shown). An angle iron (not shown) can be placed on the foundation module **110**, and the membrane is clamped between the foundation module **110** and the angle iron. The anchor bolt **120** extends through a bolt hole on the angle iron and is fastened with a nut.

Specifically, the counterbore **111** is a square dimpling, the bolt head **122** is a square bolt head. The end of the anchor bolt **120** is at least 4 cm higher than the top surface of the foundation module **110**.

It should be understood that, the anchor bolt **120** may be pre-poured onto the foundation module **110**. Alternatively, the anchor bolt **120** can be substituted by an expansion bolt punching into the foundation module **110** during installation. The counterbore **111** may not be limited to a square dimpling, e.g. it can be a round hole.

The foundation module **110** may be embodied as a concrete foundation module **110** pre-poured by reinforced concrete. The plurality of foundation modules **110** are connected end to end, and they can resist the upward and lateral tension of the membrane by their own weight.

According to the foregoing air dome foundation **100**, the foundation module **110** thereof is modularized. The foundation module **110** can be placed on the ground without excessive treatment of the ground, even holes is not necessary to be drilled on the ground. The foundation module **110** can be pre-machined in the factory, and transported to the site and installed as needed, such that the construction period is further shortened, and the construction costs are significantly reduced.

Referring to FIG. **1** again, the foundation module **110** can include a normal side module **110***a*, a both-sides module **110***b* for main door, a both-sides module **110***c* for emergency door, and a corner module **110***d*. The normal side module **110***a*, the both-sides module **110***b* for main door, and the both-sides module **110***c* for emergency door have elongated structures. The corner module **110***d* can be of an L-shaped structure.

In the illustrated embodiment, referring to FIG. **2**, both ends of a side of the foundation module **110** are provided with one row of first through holes **113**.

Referring to FIG. **4** and FIG. **5**, the air dome foundation **100** further includes a plurality of splicing plates **130** and penetrating bolts **140**. The splicing plate **130** is provided with two rows of second through holes **132**, the two rows of second through holes **132** are corresponding to a row of the first through holes **113** on an end of the two adjacent foundation modules **110**. The penetrating bolt **140** extends through the first through hole **113** and the second through hole **132**, such that two adjacent foundation modules **110** are fixed via the splicing plate **130**.

Specifically, the second through hole **132** can be an oblong hole, so as to eliminate the dimensional error of the reserved space when the foundation module **110** is poured.

The air dome foundation **100** further includes a gasket **150** and a nut **160**. The nut **160** is threadedly connected to the end of the penetrating bolt **140**, so as to fasten the penetrating bolt **140**. The gasket **150** is located between the

nut **160** and the splicing plate **130**. The penetrating bolt **140** is fastened by the nut **160** and the gasket **150**.

It should be understood that, in alternative embodiments, the foundation modules **110** can be spliced by other means, besides by using the splicing plates **130** and the penetrating bolts **140**.

In order to meet the sealing requirements, the air dome foundation **100** further includes a sealing cushion **170** disposed between adjacent two foundation modules **110** or on the bottom surface of the foundation module **110**.

Alternatively, the air dome foundation **100** further includes a sealing adhesive coated between adjacent two foundation modules **110** or on the bottom surface of the foundation module **110**. In that case, the sealing cushion **170** can be omitted accordingly.

Referring to FIG. **6**, a sidewall of the foundation module **110** is provided with at least one lifting hole **114**, so as to meet the requirement of transportation and installation. Furthermore, a sidewall of the foundation module **110** is provided with at least one exhaust hole (not shown) for exhausting or air conditioning, so as to meet the requirements of heating.

According to the foregoing air dome foundation **100**, the foundation module **110** can be pre-machined in the factory, and transported to the site and installed as needed, thus achieving modularization. During installation, the foundation module **110** can be placed on the ground without excessive treatment of the ground, such that the construction period is further shortened, and the construction costs are significantly reduced. The air dome foundation **100** is suitable for occasions where frequent movements are needed or existing ground or facilities cannot be modified or destroyed.

Although the description is illustrated and described herein with reference to certain embodiments, the description is not intended to be limited to the details shown. Modifications may be made in the details within the scope and range equivalents of the claims.

What is claimed is:

1. An air dome foundation, comprising a plurality of foundation modules, a plurality of splicing plates, a penetrating bolt, and an anchor bolt, the anchor bolt comprising a bolt head and a main body having a rod-like structure;

wherein the plurality of foundation modules are placed on the ground, the plurality of foundation modules comprises elongated side modules and corner modules, wherein the corner modules are L-shaped;

both ends of a side of the foundation module are provided with one row of first through holes, the splicing plate is provided with two rows of second through holes, the two rows of second through holes are corresponding to a row of the first through holes on an end of the two adjacent foundation modules, the penetrating bolt extends through the first through hole and the second through hole, such that two adjacent foundation modules are fixed via the splicing plate;

a bottom of the foundation module is provided with a counterbore and an anchor bolt hole extending through the foundation module, the counterbore is located at an end of the anchor bolt hole and is in connection with the anchor bolt hole, the bolt head is located in the counterbore, the main body extends through the anchor bolt hole, and an end of the main body of the anchor bolt is higher than a top surface of the foundation module, wherein the end of the main body of the anchor bolt is configured to connect to a membrane of an air dome.

2. The air dome foundation according to claim **1**, wherein the counterbore is a square dimpling, the bolt head is a square bolt head, and the end of the anchor bolt is at least 4 cm higher than the top surface of the foundation module.

3. The air dome foundation according to claim **1**, wherein the air dome foundation further comprises a sealing cushion disposed between adjacent two foundation modules or on the bottom surface of the foundation module;

or the air dome foundation further comprises a sealing adhesive coated between adjacent two foundation modules or on the bottom surface of the foundation module.

4. The air dome foundation according to claim **1**, wherein the foundation module is a concrete foundation module.

5. The air dome foundation according to claim **1**, wherein a sidewall of the foundation module is provided with at least one lifting hole.

6. An air dome comprising an air dome foundation according to claim **1**.

* * * * *